such as cyclic AMP and ADP, will simply not do. However, some other well established enzymes, notably the DNA polymerases and the RNA and DNA ligases, are also known to be capable of catalyzing this exchange reaction.

Evidence from other labs likewise reinforces the progesterone receptor's putative enzymatic role. For instance, the receptor is closely associated with the synthesis of RNA and is able to bind to polynucleotides, the stuff from which nucleic acids are made. Nucleic acid synthesis from polynucleotides depends on the presence of ATP or other high-energy molecules. Further studies, of course, are needed to determine exactly how the receptor might interact with ATP in order to influence nucleic acid synthesis, how these various interactions mesh with the receptor's interface with progesterone in the cell cytoplasm or nucleus and whether the receptor is an enzyme, an enzyme subunit or a precursor of an enzyme. □

Technology transfer: Toward a redirection

In search of new markets and armed with many good intentions, American government and industry have spent years selling or giving modern technology to underdeveloped countries. Individual successes have been spectacular, but many unfortunate side effects have also resulted. Farm machinery has increased food production, but richer farmers have sometimes benefited more than poor. Irrigation schemes have led to epidemics in some areas, and misdirected industrialization has swollen many Third World cities with slums.

To find less disruptive methods of technology transfer, the United Nations will convene an international Conference on Science and Technology for Development in 1979. In preparation for this conference, the U.S. State Department has scheduled a series of meetings involving government, business and academic leaders, to formulate an official American position. The first such meeting was held last week in Washington, and a lively interchange suggested that the course of American science and technology, as well as foreign policy, may be approaching an important watershed.

Secretary of State Henry Kissinger underscored the importance of the issue: "The problem of world order is the dominant problem of our time. We have talked a great deal about its military component, and we have an understanding of its political component. But in the decades ahead it is very probable that the social and economic aspects of international order will dominate our concerns."

If developing countries are to provide a better life for their people through modern science and technology, he said, they must look toward the industrial democracies, from whence come 90 percent of all transfers of capital. In return, Third World countries will need to stabilize primary commodity markets and offer foreign investors a business environment "free from harrassment and unreasonable restraints."

The vital connection between money, technology and quality of life is generally, but only vaguely, understood. Daniel Parker, AID administrator, expressed it in particularly stark terms: "One-third to two-thirds of the world's population . . . is essentially a nonentity in economic terms. Thus, they cannot consume." Landless, jobless and pennyless, these people can only survive if they can increase their productivity. This, in turn, requires introduction of new technology, but technology carefully selected so it does more good than harm.

To accomplish this difficult task will require more research concentrated on the problems of the small farmer and rural industry, according to James P. Grant, president of the Overseas Development Council. Little of the world's research now addresses the problems of the majority of the world's people. Crop strains need to be bred that will raise the productivity of harvests, without requiring large machinery or inputs of fertilizer. Local, renewable sources of energy must be developed to serve remote villages long before massive rural electrification is feasible. Most of all, Grant said, more social science research is needed to foretell the effects of technology transfer and improve market and production systems to enhance orderly development.

Several speakers echoed one aspect of this systems-approach to development through technology transfer. In the words of Orville Freeman, president of Business International Corp., "*Management* is the most important type of technology." While many developing countries may request what might be called "naked" technology—a factory or a patent license free from integrated market arrangements or systems of management—the speakers generally agreed that this approach is self-defeating. Herbert Fusfeld of Kennecott Copper Corp. pointed out that, ironically, even the Soviet Union is experimenting with Western-style business "complexes" (the equivalent of individual private companies, but without the profit motive) in key segments of its advanced technology industry. The implication is that Western technology cannot be entirely separated from Western institutions, though these institutions may have to be adapted.

Then came the shocker. Even the best conferences tend to drag after 6 hours and even people as accustomed to sustaining or feigning attention as these 900 invited guests tend to nod or fidget. But not after William W. Winpisinger of the Machinists and Aerospace Workers union shattered the calm aura of consensus that was slowly settling over the meeting. When talk turns to technology transfer, he stormed, "it's time for the American worker to put his hand over his wallet." American technology was developed largely at taxpayers' expense, it is a commodity with a high market value, and it belongs to the American people as a whole, he asserted.

While technical know-how may not be able to be kept corked up, he said, "we don't have to cut our own throats by exporting American jobs." The government, he warned, must make a closer accounting of what the domestic impact will be when an American company builds a plant or sells a license to some developing nation with cheap labor, whose products will soon flow back to the United States at low prices.

It was a hard act to follow. Only Orville Freeman tried. While admitting there are few statistics on just what effect technology transfer as a whole has on unemployment at home, he said in some instances it can actually help. From 1960 to 1974, for example, American companies with the highest proportion of investment outside the United States have shown the fastest growth of jobs in their U.S. plants, he said.

The conference moderator, Assistant Secretary of State Frederick Irving, called the session a "town meeting approach" toward developing a coherent foreign policy on an important issue. An equally apt analogy might be that of a circus holding a shake-down performance in its home town before hitting the road. Future engagements include a series of national and international encounters (an official U.S. National Conference will be held next October) with side-shows likely in Congress and in various private forums. If successful, these may prove to be a unique new exercise of democracy, whose ultimate implications for American science and technology cannot now even be estimated. □

What went wrong? Anatomy of failures

The course of science and technology is littered with the residue of failure. False starts, wrong turns, sudden pitfalls all hinder the path toward successful technological innovation. Some attempts make it, some don't. Everyone knows that, or should, but nevertheless the problems and failures along the way often get swept into the closet and forgotten. It's the glowing successes we remember. That's understandable, for failure is uncomfortable to be around.

In the express hope that out of failure important lessons can be learned, the editors of IEEE SPECTRUM have devoted almost an entire issue of their publication

(October) to the subject "What Went Wrong?" It's an intriguing series of case studies of technological failure. Or if not total failure, at least less than total success.

It's all in the constructive spirit of learning from errors, epitomized by inventor Peter Goldmark, who says: "Above all, somehow you must have the guts to admit to yourself—and to others—that you made a mistake and you have to make a fresh start, a change in direction." Goldmark, as the journal rightly says, is one of the United States' great inventors. Yet one of the failures described is Goldmark's EVR, electronic video recording for classroom use, a project abandoned by CBS in 1972 because of the complexity and expense of the system.

Nine other subjects—ranging from entire technological systems to single gadgets—are examined in case studies: The U.S. Postal Service's difficulty-plagued automated ZIP-code-reading equipment. 3-D radar for air-traffic control. The Browns Ferry nuclear power plant fire. The superpowerful computer Illiac IV. The implantable cardiac pacemaker (its now remarkable success came 15 years later than expected). The NASA decision to get out of the communications satellite business (a decision now being reevaluated as Japan and Europe make big strides in the field). The Great Blackout of 1965. The U.S. Navy Big Dish project in the late 1950s to build the world's largest steerable radio telescope. Viking 1's jammed scoop (a short description of how engineers analyzed and corrected the problem).

As can be seen, several of the subjects involve not failed technologies but problems met and overcome. But one project that did totally bite the dust was three-dimensional radar for airports. The attempt to develop radar that could determine airliners' height was stimulated by the collision of two airliners over New York City in December 1960. Plans were announced, but the multimillion dollar project was dead within a year. Why? Great technical obstacles (massive 160-foot towers had to be held vertical within a fraction of an inch, and 528 vertically stacked antennas and 30 miles of waveguide were required for each tower) and great cost helped do it in. "It was too big and too expensive," recalls an FAA test official. "The radar system for one air terminal didn't cost as much as a single [air-height radar]." But the real death knell came from solid-state advances that gave the competitive edge to beacon transponders that could be installed in all planes and automatically report altitude on command from the ground.

The Illiac IV computer (SN: 10/13/73, p. 236) is examined for its impact on advanced computer hardware (it was one of the first to use all-semiconductor main memories and it helped usher in highly integrated bipolar logic circuits) and for its dozens of other technological ups and downs. Its development brilliantly stretched the frontiers of computer science, but it is only a fourth its original designed size, its cost of $31 million is four times the original estimate and, according to the report, there is controversy, even bitterness, over its abilities as a real, usable machine. One participant in the project is quoted as saying, "Any impartial observer has to regard Illiac IV as a failure in a technical sense. . . . It's not obvious to me how long it will be before they pull the plug."

The IEEE SPECTRUM follows its case studies with a brief section called "What ever happened to . . .?" It's a list of eight once-promising developments that got sidetracked, untracked or delayed somewhere along the way. They are ovonics (once ballyhooed as the successor to transistors), thermoelectricity, the Picturephone, emitter-coupled logic, AM stereo, two-way cable TV, direct digital computer control, and ELF shore-to-submarine communications. Although none are dead, they all recall promises not (yet anyway) kept. □

Insisting on good laboratory practices

Each year the Food and Drug Administration receives hundreds of reports of animal studies on the safety of food additives, drugs and medical devices. The agency uses that data to decide whether to approve or reject each new product. Federal law assigns to the prospective manufacturer responsibility for testing new FDA-regulated products.

The agency formerly assumed the data it received was accurate and the experiments sound. It checked up on laboratories only when there were questions about procedures or inconsistencies in the report. Recent investigations, however, led the FDA to seriously question the general quality and integrity of the data it receives.

The FDA last week proposed a set of regulations that attempt to prevent sloppy and fraudulent research from being used as a basis for safety decisions. The regulations prescribe procedures for animal handling, equipment maintenance, division of responsibility, qualification of personnel and recording of data. The rules are titled "Good Laboratory Practice."

"Decisions about the safety of consumer products that are based, wholly or in part, on data derived from such testing are too important for the agency to accept anything less than the best scientific data that can be obtained," says the FDA proposal which was published in the Nov. 19 FEDERAL REGISTER.

The evidence is strong that at least some of the evidence previously submitted was far from the best. In one case, animals were reported as normal in appearance, awareness, appetite and thirst, when in fact they were dead. In another study, the FDA was told that animal tissues had been examined microscopically for pathology, when the samples had not even been collected. Another example, included in the proposal, involved animals that had been unintentionally sprayed and fogged with pesticides during the experiments.

The proposed regulations, which will go into effect only after a public hearing and further revision early next year, include sanctions against laboratories not meeting the standards. The consequences range from rejection of specific studies to disqualification of a laboratory from any future safety testing. Withholding of required information and misrepresentation of data submitted will remain subject to criminal prosecution.

The proposed regulations do not specify rigid or uniform experimental protocols. "The responsibility for good experimental design resides with members of the scientific community," the proposal states.

As proposed, the regulations will substantially increase laboratory paperwork. They call for records of equipment maintainance, written standard operating procedures, status reports of a "quality assurance unit," detailed protocol and approval of protocol changes in writing before their implementation. The FDA proposal states that complete and accurate reports are essential for reconstructing the study to assess the quality of the results and to reinterpret the data in light of later findings.

In deciding upon this proposal, the FDA turned down several alternatives. It concluded that requiring specific tests might hinder important experimental innovations. Licensing of testing facilities and full-time, on-site monitoring were rejected as time-consuming and not cost effective. Finally, the agency decided against shifting all or part of the burden for laboratory testing of products from the manufacturer to the FDA. "This approach would entail an enormous expenditure of agency resources because of the spectrum of regulated products, the diversity of the kinds of data needed, and the number of products submitted to the agency for approval; furthermore, it would necessitate congressional authorization," the proposal says.

Congress has added about $17 million to the FDA annual budget to be used to ensure the quality and integrity of data submitted in support of regulated products. To evaluate the practicability of administering the proposed regulations, the FDA plans in the next few months to inspect a substantial number of previously uninvestigated testing facilities.

The regulations will not affect basic research, exploratory studies, chemical characterization or clinical trials. □